Recognition and Control of VEGETABLE DISEASES

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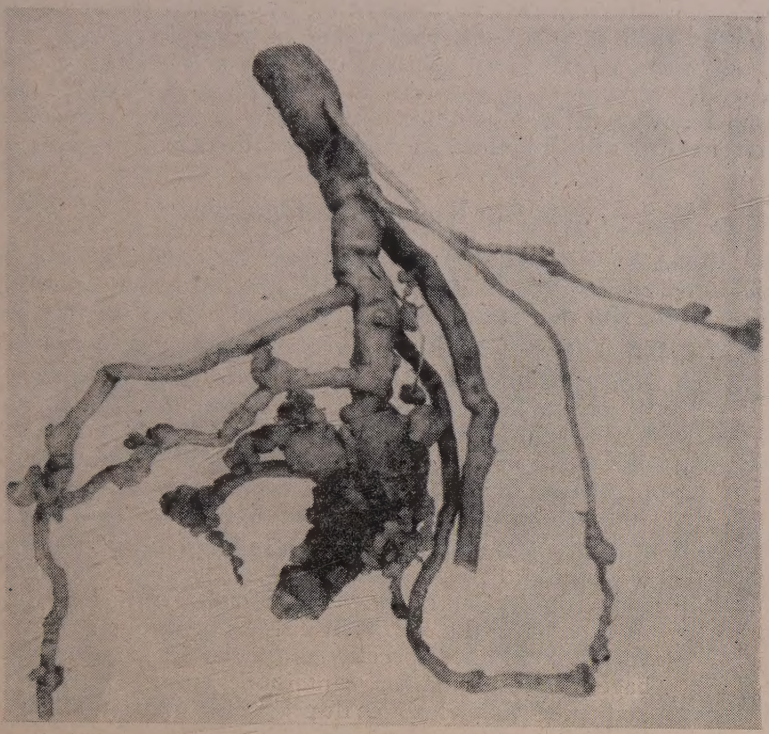

Tomato Root Infected With Root-Knot (Nematode)

Circular No. 475

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Recognition and Control of VEGETABLE DISEASES

By K. STARR CHESTER and J. HARVEY McLAUGHLIN*

Vegetable crops, like human beings, often suffer from diseases caused by germs, fungi, and other microscopic parasites. Yellowing, drying up and dying of plants, often blamed on the weather or the soil, may be brought on by plant parasites. Plant troubles such as wilt, root rots, dying of young seedlings, poor stands, rusts, mildews and spotting of leaves and fruits are more generally recognized by growers as being plant diseases. Losses from many of these destructive diseases can be easily reduced or prevented by simple and inexpensive precautions.

How to Recognize Diseases

1. *Seedlings fail to come up; seedlings wilt, fall over and die soon after coming up.* This is "damping off," a disease caused by fungi in the soil that attack the seed and seedlings. See page 8.

2. *Plants wilt or turn yellow and die before maturity.*

   A. *Roots distorted with many small to large swellings or "knots."* This is "root knot" caused by microscopic worms called "nematodes." It is present in many soils of Oklahoma and is one of the main reasons for the premature dying of tomatoes, cowpeas, okra, root crops, and melons in midsummer. See front cover and page 8.

   B. *Roots appear sound but the tissue just under the bark of stems and roots is discolored brown and abnormally wet.* This is one of the "wilt diseases," caused by fungi or bacteria in the soil. Wilt diseases occasionally become very destructive, especially on tomatoes, potatoes, cabbage, beans, cucumbers, cantaloupes, peas, watermelons, and sweet potatoes. Wilt-producing parasites live in the soil for years; but each parasite is restricted to one crop so that, as a rule, land that contains one type is safe for growing other vegetables. For example, the tomato wilt fungus attacks only tomatoes.

   C. *Roots are dead and decayed.* This is a root rot disease, of which there are several types in Oklahoma. "Texas root rot" or "cotton root rot" attacks many kinds of crops in the southernmost counties of the State.

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Affected roots have brown, hairy, fungus, threads on the surface. Mimeographed Circular 53 gives special instructions for dealing with this destructive disease.

"Southern blight," another common type of root rot, may be found in various parts of Oklahoma. Affected roots are studded with small, round, pale brown fungus masses, resembling turnip or radish seeds.

In a third type of root rot, the roots are usually blackened, with a foul-smelling decay. This is the result of excessive water in the soil, which kills the roots by excluding the air.

3. *Leaves, stems and fruits show numerous roundish, angular or irregularly shaped dead spots.* There are many of these "spot diseases," affecting various vegetable crops, caused by fungi or bacteria.

4. *A grayish-white mold or mildew covers the leaves.* This is "powdery mildew," a fungus disease particularly common on peas, cowpeas, and cucumbers. Severely affected leaves may turn yellow, dry up, and fall off; as a result, plants are usually stunted and yield poorly.

5. *Leaves are mottled with light and dark areas, curled or twisted, but not dying; plants are stunted and yield poorly.* This is "virus disease," a common type of what is called "mosaic." It especially affects beans, potatoes, tomatoes, cucumbers, and cowpeas.

How to Reduce Losses From Diseases

1. *Rotate the location of vegetable crops.* This is helpful in all cases and is indispensable where root knot and root rots are problems. Tomatoes, cowpeas, melons, okra, and other summer-growing crops should not be grown on the same land oftener than once in three years unless the soil is disinfested with a recommended chemical. Instructions for soil treatment are given in Botany and Plant Pathology Leaflet No. 1, available on request. The other years the land may be devoted to other purposes, such as poultry yard, or planted to corn, other grain crops, or early vegetables that are harvested by June. After early crops are harvested, the land should be kept free of weeds throughout the summer.

Even a small garden may be divided into thirds, with summer-growing vegetables that are susceptible to root diseases grown in a different third each year.

Mimeographed Circular 44 gives further details on controlling root knot.

2. *Use certified seed and transplants whenever possible.* Certified seed or transplants are true as to variety, free from weed seed, and free of the noxious diseases that can be controlled only by planting seed or transplants that do not carry these diseases. Virus diseases of potatoes and legumes, and a number of spotting diseases of beans and tomatoes, are best avoided by this means. Use of certified seed or plants, when available, is crop insurance worth far more than the additional cost involved.

TABLE I

Principal Disease-resistant Vegetable Varieties Recommended for Oklahoma.

Vegetable	Variety	Resistant to:
Asparagus	Mary Washington, or Martha Washington	Rust
Beans (snap)	Logan	Mosaic, mildew, bacterial blights, rust
Beans (pole)	Kentucky Wonder (some strains not resistant)	Rust, root knot
	Alabama No. 1 and No. 2	Root knot
Cabbage	Jersey Queen, or Marion Market, Resistant Golden Acre	Yellows (wilt)
Cantaloupe	"Powdery Mildew Resistant No. 45", Texas Resistant No. 1	Powdery and downy mildew
Cowpeas	Blackeye cowpeas (ask for the resistant strains) California Certified Nos. 5 and 1	Root knot and wilt
Lettuce	Great Lakes, Imperial 456	Tipburn
Peas	Alderman, Glacier, Dwarf Telephone, and others (ask for the wilt-resistant strains)	Wilt
Sweet Corn	Golden Cross Bantam, Marcross, Spancross, or Stowell's Evergreen	Bacterial wilt
Tomato	Stokesdale, Pritchard, Rutgers, Pearl Harbor, or Marglobe. The Marglobe, although resistant to many tomato diseases, is not reliable in production. Wilt susceptible variety Danmark is recommended for western part of state because of its earliness.)	Wilt
Watermelon	Hawkesbury, Kleckley No. 6, Stone Mountain No. 5, Blacklee, or Klondike R-7	Wilt

3. *Grow disease-resistant varieties.* Many new varieties of vegetables combine good production with disease resistance. Disease-resistant varieties are usually so marked in the seed catalogs. Table I lists those that have proved suitable for Oklahoma in the Oklahoma Station's vegetable variety tests. Resistant varieties offer the only effective means of controlling the common and destructive wilt diseases of tomatoes, watermelons, cabbage, and other crops.

4. *Use disease-free plants of tomatoes, cabbage, and sweet potatoes.* Plants are best bought directly from a reliable and trustworthy grower if you do not grow them yourself.

Tomato and cabbage plants should be inspected and rejected if they show root swellings, to avoid introducing root knot into the soil. The knots may vary from pinhead size up to very large and obvious swellings.

With sweet potatoes, it is best to buy certified transplants if they can be obtained, as they are from fields that have passed an inspection for disease.

5. *Plant seed treated with a recommended chemical.* Certain chemicals, when dusted on seed, protect the seed and seedlings against fungi present on the seed or in the soil. These fungi, if not destroyed, will rot the seed or kill many of the seedlings after they come up. Seed treatment gives better stands and generally healthier and more vigorous seedlings. The cost is very low as compared to the protection obtained.

Ask your seed dealer for treated seed. Many seed companies are now treating their vegetable seed and your hometown seedman can usually get treated seed for you if he does not have it on hand.

If you cannot buy seed already treated, buy a package of one of the recommended chemicals (Table II) and treat your own seed according to the directions on the package. No special equipment is needed. Small amounts of seed can be shaken with the chemical in a fruit jar, syrup can, bucket, or any other type of convenient container.

It is advisable to treat and repackage the seed during the winter months so it is ready for planting when the planting season rush begins.

The treatments marked with an asterisk (*) have been tested at the Oklahoma Experiment Station and are especially recommended. The vegetable crops thus marked suffer the greatest losses from the damping off fungi. Note that only one or two chemicals are needed to treat satisfactorily almost all kinds of vegetable seed. As a rule, cabbage, turnip and radish seed benefit little from chemical dust treatments. Bulletin B-293 gives further information on vegetable seed treatment for Oklahoma.

WARNING: CHEMICALS USED FOR SEED TREATMENT ARE POISONOUS. *Do not use treated seed for livestock feeding or human consumption. Avoid breathing dust while treating the seed.* Read directions on the package containing the seed treatment chemicals and follow them carefully.

TABLE II

Vegetable Seed Treatment Recommendations for Oklahoma.

	RECOMMENDED CHEMICALS				
Vegetable Crop	Arasan	Spergon	Semesan	Red or Yellow Cupro-cide	Zinc Oxide
Beans (snap)	X*	X*	X		
Beans (pole)	X*	X*	X		
Beans (lima)	X*	X*			
Beets	X*		X	X	
Cabbage	X	X	X		
Cantaloupe	X*	X*	X		
Carrot	X*	X*	X	X	X
Cowpeas	X*	X*	X		
Cucumber	X*	X*	X	X	
Eggplant	X	X	X		X
Lettuce	X*	X*	X	X	X
Okra	X	X			
Onion	X				
Peas	X*	X*	X	X	
Pepper	X	X	X	X	
Potatoes	(See note at bottom of this table.)				
Radish	X	X	X	X	X
Salsify	X	X*		X	X
Spinach	X*	X*		X	X
Sweet Corn	X*	X*			
Tomato	X*		X	X	X
Turnip	X	X	X	X	X
Watermelon	X*	X*	X	X	
Flower Seed	X		X		

NOTE: Irish potato and sweet potato "seed" are treated with Semesan Bel, mercuric chloride mixture or formaldehyde solution whenever treatment is necessary. Directions are given in Mimeographed Circular 36.

6. *Plant at the proper time for each vegetable in your particular locality.* Damping off fungi and other root parasites take a heavy toll if seed of warm-season crops such as melons, cucumbers, and beans are planted before the soil is thoroughly warm. Cultural practices that favor the best normal development of the crop (proper spacing, cultivation, fertilization, weed control, etc.) also reduce vegetable diseases by increasing the vigor of the plants.

7. *Dusting and spraying.* Dusting and spraying strictly for disease control are not often required in Oklahoma although they are usually required for insect control.

Dusting peas with sulphur helps to prevent powdery mildew. Use finely ground (325-mesh) dusting sulphur and apply *before* rains. Ordinary powdered sulphur is not satisfactory. Dusting sulphur, besides being ground extremely fine, also contains a "conditioner" which makes it flow readily.

Spraying with Bordeaux mixture (2-3-50, 3-6-50, or 4-4-50) or dusting with copper lime dust (20-80) or insoluble (fixed) copper dusts will reduce damage from melon anthracnose.

Leaf spotting on tomatoes, beets and many other crops can be controlled by dusting or spraying with copper or sulphur fungicides.

Spraying potatoes with DDT plus Bordeaux mixture controls both insects and leaf diseases in the same operation.

For effective insect and disease control by spraying or dusting it is imperative that the applications begin with the first appearance of the insect or disease, before the damage becomes severe.

SPRAYS AND DUSTS ARE POISONOUS to both livestock and human beings. Do not apply to portions of vegetables used as food (tomato and pepper fruits, cabbage heads, leafy vegetables, etc.) unless the poison can be readily removed by washing with water.

Avoid extra heavy applications of either sprays or dusts. A thorough, light, even-distributed spray or dust is far more effective.

8. *Practice crop sanitation.* Many plant parasites (fungi, bacteria) that attack vegetable crops overwinter in the refuse from last year's crop. **The burning of crop residues is most effective in** controlling a number of these plant disease fungi and bacteria. Therefore from the standpoint of controlling plant disease it is better to rake and burn the refuse from diseased vegetable crops instead of plowing under this potentially dangerous material.*

* Burning vegetable crop refuse destroys some of the organic material needed for productive garden soils. Where burning is practiced, additional barnyard manure or other organic fertilizer material will be needed.

Reducing Losses From Diseases

Diseases Affecting Most Vegetable Crops

Disease	Appearance of Disease	Control
DAMPING OFF Practically every crop shows losses. Especially severe on peas, spinach, beets, lettuce, carrots, cowpeas, onions, and tomatoes.	Poor stands obtained because of seed rotting in the soil. Seedlings become watersoaked, wilt, and fall over on the ground; usually die, dry up and blow away. Crop yields reduced because of weakened plants and uneven stands.	Seed treatment with chemicals recommended in Table II, page 6, protects seed and seedlings, resulting in better and more even seedling stands. Seedlings from treated seed usually produce stronger plants and bigger yields.
ROOT ROTS All vegetable crops are affected.	Generally unhealthy appearance of plants. Plants suffer from lack of water and food materials because the root system is partly or wholly destroyed. Leaves may turn yellow, wilt or fall off although no obvious signs of parasites are present. Roots show many rotted and discolored areas.	Plants should be grown under the best possible conditions. Use proper spacing, cultivation, fertilization, crop rotation, field sanitation and weed control to permit and encourage best growth of plants. Plant **treated** seed on recommended planting dates.
ROOT KNOT Most all vegetable crops are affected, especially tomatoes, cowpeas, okra, root crops, and melons.	Plants show signs of water deficiency, wilt, turn yellow, and die. Plants stunted if they live. Roots have many small pinpoint-size to extremely large knots or swellings; these may be rotten. Root system is impaired or destroyed so that the plants cannot obtain water and food materials.	Use a crop rotation system whereby resistant and susceptible crops are alternated on infested soil. The small microscopic worms causing the disease live in the soil over long periods of time so that rotation is a "must." Even a small garden can be rotated (page 3). Plant resistant varieties (pages 4 and 5.) Where the value of the land justifies the expense, one trouble may be controlled by chemical soil disinfestation as described in Botany and Plant Pathology Leaflet No. 1.

Diseases Affecting Specific Vegetable Crops

Crop and Disease	Appearance of Disease	Control
Asparagus Rust	Small red, dusty pustules on all above-ground parts of plants. Red color becomes black late in season. Plants turn yellow, die early. Yields reduced.	Plant resistant varieties: Mary Washington or Martha Washington.
Beans Bacterial blights	Watersoaked patches on leaves, stems and pods, soon become brown, dry and brittle. Spot on pods usually sunken, brick-red, and watersoaked. Yields reduced.	Plant Western-grown seed. Varieties "U. S. Refugee No. 5" and Logan are tolerant of disease. Do not cultivate, walk in or pick beans when wet with dew or rain.
Anthracnose	Most noticeable on pods as sunken, irregularly shaped, brown lesions which are covered by a pink mold in moist, damp weather. May attack leaves and stems.	Same as for bacterial blights.
Rust	Small red dusty spots occur on leaves, stems and pods; become black late in season. Severe attacks may stunt plants and reduce yields.	Control measures seldom needed. Varieties Pencil Pod Black Wax, Tendergreen, Stringless Black Valentine, Rust Resistant Kentucky Wonder, and Logan are tolerant of rust.
Mosaic	Leaves mottled with light and dark areas, twisted, curled and stunted. Yields poor.	"U. S. Refugee No. 5" and Logan are resistant. Bountiful, Stringless Black Valentine, Tendergreen, Burpee's Stringless Green Pod and Kentucky Wonder are tolerant.
Beets **Swiss Chard** Leaf spots	Small brown spots with reddish purple borders; later ashy gray to white. Small pinpoint-size black dots may be in center of spots. Spots become dry, brittle and may drop out.	Disease seldom severe enough to warrant control by spraying. Bordeaux mixture or copper-lime dust will control it. Avoid thick stands; thin to even stand.

Cabbage		
Yellows	Young seedlings wilt and die. Older plants stunted; leaves turn yellow, wilt and drop off. Plants may have one-sided appearance, seldom produce good heads.	Plant yellows-resistant varieties such as Jersey Queen, Resistant Golden Acre or Marion Market. Obtain healthy transplants.
Blackleg	Ashy gray spots on leaves and stems; small, pinpoint size black dots in older spots. Stem may be girdled near soil line, resulting in stunting, wilting or death of plants.	A 3 or 4 year rotation where needed for control. Destroy all cabbage refuse by burning. Obtain healthy transplants. Use new steam-sterilized soil in plant bed.
Cantaloupe **Cucumber** **Pumpkin** **Squash** **Watermelon**	**Bacterial wilt:** One or a few leaves may wilt, soon followed by wilting of entire plant. Plants die soon after wilting. Cut stem exudes milky-white, sticky, stringy sap.	Controlled by controlling the cucumber beetle with cryolite dust. Pull out and destroy any vines showing the disease early in the season.
Wilt diseases	**Fusarium wilt:** Plants may wilt at any stage of growth. Wilt usually begins at end of runner and progresses back to main stem. All runners may wilt, turn yellow and die. Inside of stem base shows a brown zone just beneath the surface.	Disease seldom severe except on watermelons. Plant only disease-resistant varieties (page 4.) Write for Mimeographed Circular 40 on Watermelon Wilt.
Anthracnose	Leaves have irregularly shaped brown or black dry spots; leaves shrivel and die. Fruits have sunken, irregularly shaped spots varying from pinpoint size to very large blotches. Spots may be covered by pink mold in moist conditions.	Practice 3-year rotation with non-cucurbitaceous crops. Treat seed before planting. Burn all plant refuse (watermelon vines, etc.). Spraying with Bordeaux mixture or dusting with copper-lime dust or insoluble (fixed) copper dusts will aid in control.

Cowpea		
Bacterial blights	Watersoaked lesions on leaves, stems and pods, soon becoming brown, dry and brittle.	Do not cultivate, walk in, or pick cowpeas when the vines are wet with dew or rain. Plant "Certified" seed or seed obtained from a disease-free field.
Powdery mildew	Grayish white, powdery growth on the leaves.	Sulphur dust will control (see page 7.)
Rust	Small red dusty spots on leaves.	Sulphur dust will control (see page 7.)
Mosaic	Leaves mottled with light and dark areas, twisted, curled and stunted. Poor yields.	Plant "Certified" seed or seed obtained from a disease-free field.
Lettuce		
Tip-burn	Margins of leaves turn brown and dry. Common on head lettuce but infrequent on leaf lettuce.	Maintain best growing conditions possible. Try to obtain uniform water supply by mulching or watering. The varieties Great Lakes and Imperial 456 are resistant.
Okra		
Wilt	Plants turn yellow, wilt and die or live and are stunted. Tissues beneath surface of stem are brown.	Seldom of sufficient importance to merit attention. Crop rotation recommended.
Leaf spots	Small to large, variously shaped and discolored spots on leaves.	No control measures needed.
Onion		
Field and storage rots	Bulbs covered partially or completely by molds of various colors (black, gray, etc.) which produce rotting.	Proper curing before storage aids in decreasing losses. Red and yellow onions are more resistant to rotting than white onions.
Pea		
Powdery mildew	Leaves covered with grayish-white, powdery mold. Usually becomes noticeable during late harvest in wet seasons.	Most of crop is usually harvested before disease becomes severe. Sulphur dusting will control.

Pepper		
Leaf spots	Watersoaked spots appear on leaves and fruits, become dry and may drop out.	No control measures needed.
Mosaic	Leaves mottled with light and dark areas, become yellow and may drop off. Fruits small.	See tomato mosaic.
Potato (Irish)		
Mosaic	Leaves curled, wrinkled, usually small with light and dark areas. Plants stunted, may die. Yields greatly reduced.	Plant "Certified" seed potatoes.
Leaf roll	Leaves small, rolled, stiff, leathery and close to main stem. Plants severely stunted; may turn yellow. Yields very low.	Plant "Certified" seed potatoes.
Scab	Rough, scabby, raised or sunken lesions on tubers.	Plant "Certified" seed potatoes.
Blackleg	Rolling and yellowing of leaves, followed by wilting and death of plant. Lower stem black and rotted. May kill sprouts before they emerge, resulting in poor stands. Tubers may rot in the soil.	Plant "Certified" seed potatoes. Crop rotation will reduce losses.
Wilt	Plant wilts; tissues just beneath surface of stem are brown. May cause rotting of tubers.	Plant "Certified" seed potatoes. Crop rotation will reduce losses.
Blights	Oval to irregularly shaped spots or dead areas on leaves.	Control seldom necessary. Spraying with Bordeaux mixture or dusting with copper-lime dust will control.
Tuber rot	Tubers rot in the field or in storage. Rot may be "wet" or "dry" with different degrees of discoloration. Odor may be foul or sweet.	Harvesting at proper time with care to avoid skinning or bruising the tubers, and good curing, help decrease losses. Maintain cool storage conditions.

Potato (Sweet) Wilt or stem rot	Slight yellowing and wilting of leaves followed by death of plants. Stem and roots show a brown discoloration just beneath the surface.	Plant disease-free slips. Slips from certified seed roots preferable. Use crop rotation with sweet potatoes on the land one year in a 3- or 4-year period.
Black rot	Roots with dark round spots which extend into potato, giving it a bitter taste when cooked. Spreads in storage, causing losses of entire potatoes.	Same as for wilt. Seed potatoes showing disease may be treated with corrosive sublimate (1 oz. to 8 gals. water) or Semesan Bel solutions. (**Treated sweet potatoes are poisonous. Do not use as food nor feed to livestock.**)
Storage rots	"Wet" or "dry" rots in storage with sweet or foul odors. Potatoes may be completely destroyed.	Harvesting at proper time with care to avoid bruising or skinning the potatoes and 10 to 14 days curing at 80 to 85° F. help decrease losses from these rots. Maintain 50 to 60° F. storage temperature.
Radish **Parsley** **Turnip** **Parsnip** **Mustard**		These vegetable crops have very few diseases of economic importance in Oklahoma.
Spinach Blue mold or downy mildew	Yellow spots on upper surfaces of leaves with a downy, bluish to purple mold on the underneath side. Leaves may be killed by severe attacks.	Use highest quality seed available. Treat seed and reduce planting rate to give even, uncrowded stands. Plant in raised bed in low fields. Do not plant spring spinach in the vicinity of overwintered spinach.
White rust	White, blister-like spots on the underneath sides of leaves. Leaves may be curled or rolled when severely infected. Leaves may become yellow.	Same as for blue mold. Plant flatleaved types of spinach, especially for canning purposes.

Spinach, Cont. Wilt	Stunted plants with wilted leaves. Roots rotted and brown.	Use crop rotation to reduce losses.
Pinhead rust	Large, round, dead spots on both sides of leaves with brown or black mold on spots. Market value of leaves reduced.	Maintain proper fertilizer balance in soils to keep plants in vigorous growing condition.
Mosaic or yellows	Leaves yellowed or mottled with light and dark areas. Leaves curled downward. Plants small and compact.	Where disease is severe, control weeds and plant resistant varieties such as Old Dominion and Virginia Savoy.
Physiological disease	Plants severely stunted; leaves yellow and with large, dry, dead areas. No evidence of parasites.	Avoid planting in low, wet areas. Maintain proper fertilizer balance in soils.
Sweet Corn Bacterial wilt	Plants stunted, may wilt and die. Leaves may be pale green and dry. Tassels become white. Yellow, slimy, bacterial ooze on freshly cut surfaces of stem.	Plant resistant varieties such as Golden Cross Bantam, Spancross, Marcross, and Stowell's Evergreen.
Smut	Small whitish to greenish boils appear on leaves, stalks, tassels and ears which later develop into large black, dusty boils, especially on the ears and stalks. Reduces yields.	Practice crop rotation and sanitation. If small area, boils can be removed as soon as observed, thus helping to keep down the disease.
Swiss Chard (See beets)		

Tomato Blights	Oval to irregularly shaped spots or dead areas on leaves.	Control seldom necessary. Spraying or dusting with fixed copper compounds will control the disease.
Leaf spots	Dark brown roundish spots with small pinpoint-sized black dots on leaves. Leaves die and fall off.	Grow more resistant varieties such as Marglobe and Break-O-Day. Dusting or spraying with copper fungicides will control. Do not disturb wet plants.
Wilt	Leaves wilt, followed by yellowing. Plants may die; are usually stunted if they live. Typical brownish discoloration of tissues just beneath surface of stem.	Plant resistant varieties such as Rutgers Pearl Harbor, Stokesdale, Pritchard, and Marglobe. Other resistant varieties are available.
Mosaic	Mottling of leaves; leaves may be curled and dwarfed. Plants usually stunted Yields reduced.	Obtain healthy plants. Avoid handling healthy plants after handling diseased ones or smoking or chewing tobacco which usually contains the mosaic virus.
Blossom end rot	Fruits develop dark, sunken spots at the blossom end. Caused by irregular water-supply. Is most noticeable after drought periods.	Try to maintain uniform water supply by mulching and watering. The Pritchard and Marglobe varieties are less susceptible to this condition than many other varieties.
Blossom drop	Flower buds and blossoms drop off without setting fruit. Yields reduced.	Set sturdy plants to field as early as season allows. Use early and medium-early varieties to assure the set of a good crop of fruits before hot weather arrives. Fertilize the crop properly and keep it adequately supplied with water.

COOPERATIVE EXTENSION WORK
IN
AGRICULTURE AND HOME ECONOMICS
STATE OF OKLAHOMA

SHAWNEE BROWN, Director

OKLAHOMA AGRICULTURAL AND
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